4.2 Building Envelope

The building envelope is a critical component of any facility since it both protects the building occupants and plays a major role in regulating the indoor environment. Consisting of the building's roof, walls, windows, and doors, the envelope controls the flow of energy between the interior and exterior of the building. The building envelope can be considered the selective pathway for a building to work with the climate—responding to heating, cooling, ventilating, and natural lighting needs.

Opportunities

For a new project, opportunities relating to the building envelope begin during the predesign phase of the facility. An optimal design of the building envelope may provide significant reductions in heating and cooling loads—which in turn can allow downsizing of mechanical equipment. When the right strategies are integrated through good design, the extra cost for a high-performance envelope may be paid for through savings achieved by installing smaller HVAC equipment.

With existing facilities, facility managers have much less opportunity to change most envelope components. Reducing outside air infiltration into the building by improving building envelope tightness is usually quite feasible. During reroofing, extra insulation can typically be added with little difficulty. Windows and insulation can be upgraded during more significant building improvements and renovations.

Technical Information

WINDOWS

Glazing systems have a huge impact on energy consumption, and glazing modifications often present an excellent opportunity for energy improvements in a building. Appropriate glazing choices vary greatly, depending on the location of the facility, the uses of the building, and (in some cases) even the glazing's placement on the building. In hot climates, the primary strategy is to control heat gain by keeping solar energy from entering the interior space while allowing reasonable visible light transmittance for views and daylighting. Solar screens that intercept solar radiation, or films that prevent infrared and ultraviolet transmission while allowing good visibility, are useful retrofits for hot climates.

In colder climates, the focus shifts from keeping solar energy out of the space to reducing heat loss to the outdoors and (in some cases) allowing desirable solar radiation to enter. Windows with two or three glazing layers that utilize low-emissivity coatings will minimize conductive energy transmission. Filling the spaces between the glazing layers with an inert low-conductivity gas, such as argon, will further reduce heat flow. Much heat is also lost through a window's frame. For optimal energy performance, specify a low-conductivity frame material, such as wood or vinyl. If metal

Source: Lawrence Berkeley National Laboratory

By taking an integrated approach to combining building envelope and lighting components, even greater energy savings and increased occupant comfort can be attained. The photos above show dynamically controlled window and lighting systems implemented by the Lawrence Berkeley National Laboratory at the Oakland, California, Federal Building. The blinds adjust, and electric lights dim, in response to real-time variations in sun and sky conditions. Lighting energy savings were 20% in winter and 30–50% in summer. Overall cooling savings for the summer were 5–15%.

frames are used, make sure the frame has thermal breaks. In addition to reducing heat loss, a good window frame will help prevent condensation—even high-performance glazings may result in condensation problems if those glazings are mounted in inappropriate frames or window sashes.

Fenestration can be a source of discomfort when solar gain and glare interfere with work station visibility or increase contrast and visual discomfort for occupants. Daylighting benefits will be negated if glare forces occupants to close blinds and turn on electric lights, for example, to perform visual tasks optimally.

Facility managers should choose appropriate window technology that is cost-effective for the climate conditions. Computer modeling, using a tool such as *DOE-2* or *Energy-10*, will help determine which glazing system is most appropriate for a particular climate. In coastal California, for example, single glazing may be all that can be economically justified, while in both hotter and colder climates, more sophisticated glazings are likely to be much more effective.

WALLS AND ROOFS

For buildings dominated by cooling loads, it makes sense to provide exterior finishes with high reflectivity or wall-shading devices that reduce solar gain. Reflective roofing products help reduce cooling loads because the roof is exposed to the sun for the entire operating day. Specify roofing products that carry the ENERGY STAR® roof label—for low-slope roofing products, these have an initial reflectivity of at least 65%. ENERGY STAR roof products are widely available with single-ply roofing, as well as various other roofing systems.

Wall shading can reduce solar heat gain significantly—use roof overhangs, window shades, awnings, a canopy of mature trees, or other vegetative plantings, such as trellises with deciduous vines. To reduce cooling loads, wall shading on the east and west is most important, though especially for buildings with year-round cooling loads, south walls will benefit from shading as well. In new construction, providing architectural features that shade walls and glazings should be considered. In existing buildings, vegetative shading options are generally more feasible.

INSULATION

With new buildings, adding more wall insulation than normal can be done for a relatively low-cost premium. Also consider thermal bridging, which can significantly degrade the rated performance of cavity-fill insulation that is used with steel framing. With steel framing, consider adding a layer of rigid insulation.

Boosting wall insulation levels in existing buildings is difficult without expensive building modifications. One option for existing buildings is adding an exterior insulation and finish system (EIFS) on the outside of the current building skin. With EIFS, use only systems that include a drainage layer to accommodate small leaks that may occur over time—avoid *barrier-type* systems.

Roof insulation can typically be increased relatively easily during reroofing. At the time of reroofing, consider switching to a *protected-membrane* roofing system, which will allow reuse of the rigid insulation during future reroofing—thus greatly cutting down on landfill disposal.

While we think of insulation as a strategy for cold climates, it makes sense in cooling climates as well. The addition of insulation can significantly reduce air conditioning costs and should be considered during any major renovation project. Roofs and attics should receive priority attention for insulation retrofits because of the ease and relative low cost.

Insulation is a guideline item under RCRA §6002 and should be purchased with recycled content. Federally funded projects are required to use insulation materials with minimum recycled content that varies depending on the type of insulation. Also consider the ozone-depletion potential of rigid insulation materials. Most extruded polystyrene and polyisocyanurate insulation is produced with ozone-depleting hydrochlorofluorocarbons (HCFCs), though ozone-safe alternatives are beginning to appear.

Contacts

Oak Ridge National Laboratory, Bldg 3147, P.O. Box 2008 – MS6070, Oak Ridge, TN 37831; (423) 574-5207; www.ornl.gov/roofs+walls. DOE *Insulation Fact Sheet* available online.

ENERGY STAR Roof Products Program, Office of Air and Radiation, U.S. Environmental Protection Agency, Washington, DC 20460; 202/564-9124; www.epa.gov/energystar.

Photo: Craig Miller Productions and DOE

Installation of light-colored roofing to better reflect sunlight and reduce interior temperature.